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**Earth Science
Data and Information System (ESDIS)
Level 1 Product Generation System (LPGS)
Output Files Data Format Control Book**

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National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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Preface

This Data Format Control Book (DFCB) is maintained and controlled by the Level 1 Product Generation System (LPGS) Project Configuration Management Board (PCMB) and may be updated or revised only on approval by the PCMB. Comments and questions regarding this DFCB should be directed to

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Abstract

This Data Format Control Book (DFCB) presents detailed data formats of the output files generated by the Level 1 Product Generation System (LPGS). The LPGS produces Level 1 output files from Level 0R images based on user requests. The LPGS produces images in the following formats: Hierarchical Data Format (HDF)-Earth Observing System (EOS), FAST-Landsat 7 (FAST-L7), or Georeference Tagged Image File Format (GeoTIFF).

This document is based on the requirements contained in the *Earth Science Data and Information System (ESDIS) Level 1 Product Generation System (LPGS) Functional and Performance Requirements Specification* and the *Level 1 Product Generation System (LPGS) Operations Concept*.

Keywords: *Data Format Control Book (DFCB), Earth Observing System Data and Information System (EOSDIS), Earth Resources Observation System (EROS) Data Center Distributed Active Archive Center (EDC DAAC), EOSDIS Core System (ECS), FAST format, Georeference Tagged Image File Format (GeoTIFF), Hierarchical Data Format (HDF), Landsat 7, Level 1 Product, Level 1 Product Generation System (LPGS)*

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Section 1. Introduction

1.1 Purpose

This Data Format Control Book (DFCB) defines in detail the formats of the output files generated by the Level 1 Product Generation System (LPGS). The LPGS generates Level 1 (L1) products in response to L1 product generation requests received from the Earth Observing System Data and Information System (EOSDIS) Core System (ECS).

1.2 Scope

This DFCB describes the formats and data contents of the LPGS output files. The formats discussed are Hierarchical Data Format (HDF)-Earth Observing System (EOS), FAST-Landsat 7 (FAST-L7), and Georeference Tagged Image File Format (GeoTIFF). These output file formats are based on the requirements contained in the *Earth Science Data and Information System (ESDIS) Level 1 Product Generation System (LPGS) Functional and Performance Requirements Specification (F&PRS)* (Applicable Document 1) and the *Level 1 Product Generation System (LPGS) Operations Concept* (Applicable Document 2).

The functional, performance, operational, and interface design details for the transfer of these files from the LPGS to the ECS are contained in the *Interface Control Document (ICD) Between the EOSDIS Core System (ECS) and the Level 1 Product Generation System (LPGS)* (Applicable Document 3). The HDF-EOS L1 product formats are heavily derived from the formats of the Level 0R (L0R) products so as to cause less impact on the user community and to provide general consistency in ECS output. The L0R product formats are described in the *Landsat 7 System Zero-R Distribution Product Data Format Control Book, Volume 5, Book 1* (Applicable Document 4). In addition, the output files defined in this DFCB are based on the already established FAST and GeoTIFF standards. Current Earth Observation Satellite (EOSAT) Landsat products are in the FAST-B format, and new EOSAT products will be in FAST-C format. The Landsat 7 L1 products will be in FAST-L7 format. This is the FAST-C format modified to accommodate the features of the Enhanced Thematic Mapper Plus (ETM+) instrument. Other remote-sensed images, from platforms such as SPOT, are in GeoTIFF.

The file formats contained in this DFCB are applicable to the interface between the ECS and the LPGS. This DFCB does not contain specific details on the file formats of the products distributed by the ECS to the customer. Detailed formats for the L1 products will be defined in future documentation.

1.3 Intended Users

This document is intended as a supplement to the *ICD Between the ECS and the LPGS* (Applicable Document 3). Therefore, the LPGS and the EOSDIS projects are the primary users of this document, with the user community as the secondary user. This document contains detailed information on the LPGS output data file formats to allow users on both sides to proceed with independent development of the LPGS and the ECS.

1.4 Definitions

Level 0R (L0R) digital image—Spatially reformatted, demultiplexed, and, unrectified subinterval data

L0R product—L0R digital image plus radiometric, calibration, attitude, and ephemeris data in HDF. The L0R product consists of the following files:

- L0R digital image
- Internal calibrator (IC) data—Calibration data file containing all the calibration data received on a major frame basis for a given subinterval
- Mirror scan correction data (MSCD)—Scan direction and error information for a given subinterval
- Payload correction data (PCD)—Information on spacecraft attitude and ephemeris, including quality indicators for each subinterval
- Metadata—Descriptive information about the L0R digital image and names of appended files associated with the image
- Calibration parameter file (CPF)—Formatted file containing gains, biases, and offsets for the instrument and detectors

Level 1R (L1R) digital image—Radiometrically corrected but not geometrically resampled

Level 1R (L1R) product—L1 product packaged by the LPGS, distributed by the ECS to the customer, and consisting of the following in HDF-EOS format:

- L1R digital image
- IC data—Calibration data file containing all the calibration data received on a major frame basis for a given subinterval
- Consensus MSCD—Scan direction and error information for a given subinterval
- Consensus PCD—Information on spacecraft attitude and ephemeris, including quality indicators for each subinterval
- Metadata—Descriptive information about the L1 digital image and names of appended files associated with the image
- CPF—Formatted file containing gains, biases, and offsets for the instrument and detectors
- Geolocation table—Scene corner coordinates and scan line numbers

Level 1G (L1G) digital image—Radiometrically corrected and resampled for geometric correction and registration to geographic map projections

Level 1G (L1G) product—L1 product packaged by the LPGS and distributed by the ECS to the customer; includes, for all requested bands, FAST-L7 or GeoTIFF format L1G image and associated data accommodated by the format; or HDF-EOS format L1G image and metadata

Interval—Time duration between the start and stop of an imaging operation (observation) of the Landsat 7 ETM+ instrument

Subinterval—Segment of time corresponding to a portion of an observation within a single Landsat 7 contact period

Worldwide Reference System (WRS) scene—Digital image that covers an area equivalent to one of the 57,784 scene centers (233 paths by 248 rows areas) defined by the WRS structure

Section 2. Applicable Documents

The following documents provide additional detail and reference information regarding the format of the LPGS output files.

1. National Aeronautics and Space Administration (NASA)/Goddard Space Flight Center (GSFC), 510-FPD/0196, *Earth Science Data and Information System (ESDIS) Level 1 Product Generation System (LPGS) Functional and Performance Requirements Specification*, Review, November 1997
2. --, 510-3OCD/0196 (CSC 10034093), *Level 1 Product Generation System (LPGS) Operations Concept*, February 1997
3. --, 423-41-55, *Interface Control Document (ICD) Between the Earth Observing System Data and Information System (EOSDIS) Core System (ECS) and the Level 1 Product Generation System (LPGS)*, October 1997
4. --, 430-11-06-007-0, *Landsat 7 System Zero-R Distribution Product Data Format Control Book, Volume 5, Book 1*, September 1997
5. --, 430-15-01-002-0, *Image Assessment System (IAS) Calibration Parameter File Definition*, June 1997
6. --, 505-10-36, *Earth Science Data and Information System (ESDIS) Project Mission Specific Requirements for the Landsat 7 Mission Level 1 Processing*, July 1997
7. GeoTIFF Specification (available at <http://home.earthlink.net/~ritter/geotiff/spec/geotiffhome.html>)
8. Space Imaging EOSAT, Technical Papers, FAST-C Format Specification (available at http://www.spaceimage.com/home/pubs/tech_papers/fstfmt_c.html)
9. Jet Propulsion Laboratory, California Institute of Technology, "Object Description Language Specification and Usage," Chapter 12 of *Planetary Data System Standards Reference*, Version 3.2, July 24, 1995 (available at <http://pds.jpl.nasa.gov/stdref/chap12.htm>)

Section 3. Overview of LPGS Output Files

The L1R digital image is very similar to the L0R digital image, except that the image data are radiometrically corrected. In addition, the format 1 and format 2 PCD files are combined into one consensus file, as are the format 1 and format 2 MSCD files. The consensus file is a single file created from the two original files included with the L0R product and with errors corrected. The L1R product is available in HDF-EOS only. The L1G digital image is geometrically corrected and is available in three format options: FAST-L7, GeoTIFF, and HDF-EOS.

Tables 3-1 through 3-3 detail the L1 product components for each format.

Table 3-1. FAST-L7 Product Components

TBD

Table 3-2. GeoTIFF Product Components

Component	L1G
File (contains both image data and metadata)	X

Table 3-3. HDF-EOS Product Components

Component	L1R	L1G
L1 digital image (for each requested band)	X	X
IC data—format 1 (for bands 1 through 6 low)	X	
IC data—format 2 (for bands 6 high through 8)	X	
Scan line offsets—format 1 (for bands 1 through 6 low)	X	
Scan line offsets—format 2 (for bands 6 high through 8)	X	
MSCD (consensus)	X	
PCD (consensus)	X	
CPF	X	
Metadata (LPS)—format 1	X	
Metadata (LPS)—format 2	X	
Metadata (LPGS)	X	X
Geolocation table	X	
HDF directory file	X	X

3.1 FAST-L7

TBD

3.2 GeoTIFF

GeoTIFF defines a set of public domain TIFF tags that describe all cartographic and geodetic information associated with geographic TIFF imagery. GeoTIFF is a means for tying a raster image to a known model space or map projection and for describing those projections. A metadata format provides geographic information to associate with the image data, but the TIFF file structure allows both the metadata and the image data to be encoded into the same file. The TIFF file is grayscale, scanline, uncompressed, and 8-bit unsigned integers. The file naming convention for the GeoTIFF product is

L7fpprrr_rrrYYYYMMDD.tif

where

- L7 = Landsat 7 mission
- f = ETM+ format (1 or 2) (data not pertaining to a specific format defaults to 1)
- ppp = starting path of the product
- rrr_rrr = starting and ending rows of the product
- YYYYMMDD = acquisition date of the image

3.3 HDF-EOS

Both the L1R and the L1G products can be ordered in HDF-EOS. The file naming convention for the HDF-EOS product files is

L7fpprrr_rrrYYYYMMDD_aaa.xxx

where

- L7 = Landsat 7 mission
- f = ETM+ format (1 or 2) (data not pertaining to a specific format defaults to 1)
- ppp = starting path of the product
- rrr_rrr = starting and ending rows of the product
- YYYYMMDD = acquisition date of the image
- aaa = file type (defined in LPGS metadata)
- xxx = product type (L1R or L1G)

3.3.1 Image File

Each requested image band is self-contained in a single file. The file format is described in the L0R DFCB, Volume 5, Book 1 (Applicable Document 4). The L1R image files will be in absolute units scaled to 16 bits. The L1G images will be 8-bit unsigned integers scaled, if necessary, to fit within this range.

3.3.2 Ancillary Data

The remaining files included with the HDF-EOS product include the IC data, scan line offsets, MSCD, PCD, CPF, metadata, geolocation table, and HDF directory file. See Table 3-3 for a complete listing of which files are included with each product. These files are described in detail in Section 4.3

Section 4. LPGS Output File Formats

4.1 FAST-L7 File Formats

TBD

4.2 GeoTIFF File Formats

The TIFF tags are in the same file as the TIFF image. The tags convey information about the image and are TIFF's version of metadata. The tags describe the image with information the TIFF reader needs to control the appearance of the image on the user's screen.

A complete description of the raster data requires georeferencing of the data, which is accomplished through the use of tags. For the most common applications, the transformation raster and model space may be defined with a set of raster-to-model tiepoints and scaling parameters. The following tags may be used for this purpose: ModelTiepointTag, ModelPixelScaleTag, and ModelTransformationTag.

ModelTiepointTag

Tag = 33922

Type = DOUBLE

N = 6*K, K = number of tiepoints

Alias: GeoreferenceTag

Owner: Intergraph

This tag stores the raster-to-model tiepoint pairs in the order

ModelTiepointTag = (... , I, J, K, X, Y, Z...),

where (I, J, K) is the point at location (I, J) in raster space with pixel-value K, and (X, Y, Z) is a vector in model space.

A raster image may be georeferenced simply by specifying its location, size, and orientation in the model coordinate space. Because the relationship between the raster space and the model space often will be an exact, affine transformation, the relationship can be defined using one set of tiepoints and the ModelPixelScaleTag, which gives the vertical and horizontal raster grid cell size.

NOTE: The next two tags are optional tags provided for defining exact, affine transformations between raster and model space; baseline GeoTIFF files may use either, but will never use both within the same TIFF image directory.

ModelPixelScaleTag:

Tag = 33550

Type = DOUBLE

N = 3

Owner: SoftDesk

This tag may be used to specify the size of raster pixel spacing in the model space units, when the raster space can be embedded in the model space coordinate system without rotation, and consists of the following three values:

ModelPixelScaleTag = (ScaleX, ScaleY, ScaleZ)

where ScaleX and ScaleY give the horizontal and vertical spacing of raster pixels and ScaleZ is used primarily to map the pixel value of a digital elevation model into the correct Z-scale.

A single tiepoint in the ModelTiepointTag, together with the ModelPixelScaleTag, completely determines the relationship between raster and model space.

The ModelPixelScaleTag must not be used if the raster image requires rotation or shearing to place it into the standard model space. In these cases, the transformation shall be defined with the ModelTransformationTag.

ModelTransformationTag:

Tag = 34264

Type = DOUBLE

N = 16

Owner: JPL Cartographic Applications Group

This tag may be used to specify the transformation matrix between the raster space and the model space.

4.3 HDF-EOS File Formats

4.3.1 Image Files

Each band in the requested product is contained in a separate file. The L1R image is radiometrically corrected but not geometrically resampled. The L1G image is radiometrically corrected and resampled for geometric correction and registration to geographic map projections.

4.3.2 Internal Calibrator Data Files

The IC data files are included only with the L1R output product and are described in the L0R DFCB, Volume 5, Book 1. The IC data format 1 file is provided with products that include bands 1 through 6 low image data; the format 2 file is provided with products that include bands 6 high through 8. These data are subsetted to correspond to the user-requested product.

4.3.3 Scan Line Offsets

The scan line offsets are included only with the L1R product and are described in the L0R DFCB, Volume 5, Book 1. The scan line offsets format 1 file is provided with products that include

bands 1 through 6 low image data; the format 2 file is provided with products that include bands 6 high through 8. These data are subsetted to correspond to the user-requested product.

4.3.4 Mirror Scan Correction Data File

The MSCD data file is included only with the L1R output product and is described in the L0R DFCB, Volume 5, Book 1. One consensus MSCD file is provided. A consensus MSCD file is a single MSCD file, created from the two original files included with the L0R product, with errors corrected according to LPGS processing algorithms. These data are subsetted to correspond to the user-requested product.

4.3.5 Payload Correction Data File

The PCD data file is included only with the L1R output product and is described in the L0R DFCB, Volume 5, Book 1. One consensus PCD file is provided. A consensus PCD file is a single PCD file created from the two original files included with the L0R product and with errors corrected according to LPGS processing algorithms. This consensus PCD file will not be subsetted.

4.3.6 Calibration Parameter File

The CPF is a formatted file containing radiometric and geometric processing parameters required for L1 processing. It is provided only with the L1R product, without modification from what was provided with the L0R product. The format is described in the L0R DFCB, Volume 5, Book 1, and the *Image Assessment System (IAS) Calibration Parameter File Definition* (Applicable Document 5).

4.3.7 Metadata File (Landsat Processing System)

The Landsat Processing System (LPS) metadata file is included with the L1R output product without modification from what was provided from the ECS. The file format is described in the L0R DFCB, Volume 5, Book 1. The metadata format 1 and format 2 files are provided with all L1R products.

Some information in the LPS metadata file pertains to parent subintervals of the LPGS product and may not be applicable to L1 products produced by the LPGS.

4.3.8 Metadata File (LPGS)

The LPGS metadata file is created during product generation and contains information specific to the product ordered. Table 4-1 lists the full contents of the LPGS metadata file. This file contains all applicable image coordinate information from the ECS metadata provided with the L0R product.

4.3.9 Geolocation Index File

The geolocation index file contains scene corner coordinates and their product-specific scan line numbers and is included only with the L1R product. The format of this file is described in the L0R DFCB, Volume 5, Book 1.

4.3.10 HDF Directory File

The directory file contains all the pointers, file size information, and data objects required to open and process the L1 product using the HDF library and interface routines.

4.3.11 Vgroup Definitions

The Vgroup structure was designed to associate related HDF data objects. Any HDF data object [e.g., Vdata, scientific data sets (SDSs), attributes] can be included in an HDF Vgroup definition. Vgroups employ Vgroup names and Vgroup classes for characterizing a collection of data objects and for searching activities. Three classes are recognized for the L1 HDF-EOS product: image data, correction data, and metadata.

The HDF Vgroup interface consists of routines for accessing and getting information about the L1 product Vgroups. This information is stored in the HDF data directory.

The Vgroups used to relate the different data objects that make up a complete L1 product are presented in Table 4-2.

Table 4-1. LPGS Metadata File (1 of 7)

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
GROUP	18	= LPGS_METADATA_FILE	Beginning of first level object description language (ODL) group. It indicates start of LPGS metadata file level group
GROUP	18	= METADATA_FILE_INFO	Beginning of metadata file information group
REQUEST_ID	20	TBS	Unique product generation request ID generated by ECS
PRODUCT_CREATION_TIME	20	= YYYY-MM-DDThh:mm:ssZ where YYYY = 4-digit Julian year MM = month number of Julian year (01-12) DD = day of Julian month (01-31) T indicates start of time information in ODL ASCII time code format hh = hours (00-23) mm = minutes (00-59) ss = seconds (00-59) Z indicates "Zulu" time (same as GMT)	LPGS system date and time when metadata file for L1 product set was created. For ease of human readability, this date and time are presented in ODL ASCII format. Time is expressed as Universal Coordinated Time (UTC) [also known as Greenwich mean time (GMT)]. Insertion of additional characters "T" and "Z" is required to meet ODL ASCII format
STATION_ID	3	= "EDC"	Unique 3-letter code identifying originating ground station
LANDSAT7_XBAND	1	= "1", "2", or "3"	Landsat 7 X-band used to downlink data to LGS
GROUND_STATION	3	= "NNN"	Ground station that received data
LPS_PROCESSOR_NUMBER	1	= 1-9	LPS processor number
DATEHOUR_CONTACT_PERIOD	7	= YYDOYHH	Date and hour of contact period
SUBINTERVAL_NUMBER	2	= 00-99	Subinterval number within contact period
END_GROUP	18	= METADATA_FILE_INFO	End of metadata information group
GROUP	16	= PRODUCT_METADATA	Beginning of product metadata group
PRODUCT_TYPE	3	= "L1G" or "L1R"	Identifier to inform user of product type
SPACECRAFT_ID	8	= "Landsat7"	Name of satellite platform
SENSOR_ID	4	= "ETM+"	Name of imaging sensor
ACQUISITION_DATE	20	= YYYYMMDD	Date image was acquired
WRS_PATH	3	= NNN, where NNN = path number (000-233)	WRS path value for product
STARTING_ROW	3	= NNN, where NNN = row of first full or partial scene in product (000-248)	Starting WRS row
ENDING_ROW	3	= NNN, where NNN = row of last full or partial scene in product (000-248)	Ending WRS row
BAND_COMBINATION	9	= NNNNNNNNN, where NNNNNNNNN = e.g., 123456678 for all bands present, 123----8 for bands 1, 2, 3, 8. A '-' is a position holder for absent bands	LPGS-generated indicator of bands present for product ordered. First 6 is format 1, band 6. Second 6 is format 2, band 6
PRODUCT_UL_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with 4-digit precision) Positive (+) value indicates North latitude; negative (-) value indicates South latitude	LPGS-calculated "actual" latitude value for upper left corner of product

Table 4-1. LPGS Metadata File (2 of 7)

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
PRODUCT_UL_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with 4-digit precision) Positive (+) value indicates East longitude; negative (-) value indicates West longitude	LPGS-calculated "actual" longitude value for upper left corner of product
PRODUCT_LR_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with 4-digit precision)	LPGS-calculated "actual" latitude value for lower right corner of product
PRODUCT_LR_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with 4-digit precision)	LPGS-calculated "actual" longitude value for lower right corner of product
BAND1_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_B10.xxx"	LPGS-generated external element file name for band 1
BAND2_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_B20.xxx"	LPGS-generated external element file name for band 2
BAND3_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_B30.xxx"	LPGS-generated external element file name for band 3
BAND4_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_B40.xxx"	LPGS-generated external element file name for band 4
BAND5_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_B50.xxx"	LPGS-generated external element file name for band 5
BAND6L_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_B61.xxx"	LPGS-generated external element file name for band 6, format 1
BAND6H_FILE_NAME	29	"L72pprrr_rrrYYYYMMDD_B62.xxx"	LPGS-generated external element file name for band 6, format 2
BAND7_FILE_NAME	29	"L72pprrr_rrrYYYYMMDD_B70.xxx"	LPGS-generated external element file name for band 7
BAND8_FILE_NAME	29	"L72pprrr_rrrYYYYMMDD_B80.xxx"	LPGS-generated external element file name for band 8
IC_DATA_F1_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_CAL.xxx"	LPGS-generated external element file name for format 1 internal calibrator data (1R product only)
IC_DATA_F2_FILE_NAME	29	"L72pprrr_rrrYYYYMMDD_CAL.xxx"	LPGS-generated external element file name for format 2 internal calibrator data (1R product only)
SCAN_SHIFTS_F1_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_SLO.xxx"	LPGS-generated external element file name for format 1 scan line shifts (1R product only)
SCAN_SHIFTS_F2_FILE_NAME	29	"L72pprrr_rrrYYYYMMDD_SLO.xxx"	LPGS-generated external element file name for format 2 scan line shifts (1R product only)
MSCD_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_MSD.xxx"	LPGS-generated external element file name for consensus MSCD (1R product only)
PCD_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_PCD.xxx"	LPGS-generated external element file name for consensus PCD (1R product only)
METADATA_LPS1_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_MTA.xxx"	LPGS-generated external element file name for LPS format 1 metadata (1R product only)
METADATA_LPS2_FILE_NAME	29	"L72pprrr_rrrYYYYMMDD_MTA.xxx"	LPGS-generated external element file name for LPS format 2 metadata (1R product only)
METADATA_LPGS_FILE_NAME	29	"L71pprrr_rrrYYYYMMDD_MTL.xxx"	LPGS-generated external element file name for LPGS metadata

Table 4-1. LPGS Metadata File (3 of 7)

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
CPF_FILE_NAME	26	"L7CPF.YYYYMMDD.YYYYMMDD.nn" where YYYYMMDD = effective start date and effective end date, respectively nn = incrementing number within quarter (01-99)	ECS-generated external element file name for IAS CPF (1R product only)
GEOLOCATION_FILE_NAME	29	"L71pppprrrrrrYYYYMMDD_GEO.xxx"	LPGS-generated external element file name for geolocation table (1R product only)
HDF_DIR_FILE_NAME	29	"L71pppprrrrrrYYYYMMDD_HDF.xxx"	LPGS-generated file name for HDF directory file
END_GROUP	16	= PRODUCT_METADATA	End of product metadata group
GROUP	18	= PRODUCT_PARAMETERS	Beginning of product parameters group (both 1R and 1G products)
CALIBRATION_METHOD	3	= "CPF" for CPF gains = "IC" for IC gains	Calibration method used by LPGS in creating image
MAX_DETECTED_RADIANCE_ LEVEL_BAND1	16	TBS	Maximum detectable radiance value for band 1
MIN_DETECTED_RADIANCE_ LEVEL_BAND1	16	TBS	Minimum detectable radiance value for band 1
MAX_DETECTED_RADIANCE_ LEVEL_BAND2	16	TBS	Maximum detectable radiance value for band 2
MIN_DETECTED_RADIANCE_ LEVEL_BAND2	16	TBS	Minimum detectable radiance value for band 2
MAX_DETECTED_RADIANCE_ LEVEL_BAND3	16	TBS	Maximum detectable radiance value for band 3
MIN_DETECTED_RADIANCE_ LEVEL_BAND3	16	TBS	Minimum detectable radiance value for band 3
MAX_DETECTED_RADIANCE_ LEVEL_BAND4	16	TBS	Maximum detectable radiance value for band 4
MIN_DETECTED_RADIANCE_ LEVEL_BAND4	16	TBS	Minimum detectable radiance value for band 4
MAX_DETECTED_RADIANCE_ LEVEL_BAND5	16	TBS	Maximum detectable radiance value for band 5
MIN_DETECTED_RADIANCE_ LEVEL_BAND5	16	TBS	Minimum detectable radiance value for band 5
MAX_DETECTED_RADIANCE_ LEVEL_BAND6L	16	TBS	Maximum detectable radiance value for band 6 low
MIN_DETECTED_RADIANCE_ LEVEL_BAND6L	16	TBS	Minimum detectable radiance value for band 6 low
MAX_DETECTED_RADIANCE_ LEVEL_BAND6H	16	TBS	Maximum detectable radiance value for band 6 high
MIN_DETECTED_RADIANCE_ LEVEL_BAND6H	16	TBS	Minimum detectable radiance value for band 6 high
MAX_DETECTED_RADIANCE_ LEVEL_BAND7	16	TBS	Maximum detectable radiance value for band 7
MIN_DETECTED_RADIANCE_ LEVEL_BAND7	16	TBS	Minimum detectable radiance value for band 7
MAX_DETECTED_RADIANCE_ LEVEL_BAND8	16	TBS	Maximum detectable radiance value for band 8
MIN_DETECTED_RADIANCE_ LEVEL_BAND8	16	TBS	Minimum detectable radiance value for band 8
BAND1_GAIN	1	= "L" for low or "H" for high	Gain state for band 1's first data line if part of product
BAND2_GAIN	1	= "L" for low or "H" for high	Gain state for band 2's first data line if part of product

Table 4-1. LPGS Metadata File (4 of 7)

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
BAND3_GAIN	1	= "L" for low or "H" for high	Gain state for band 3's first data line if part of product
BAND4_GAIN	1	= "L" for low or "H" for high	Gain state for band 4's first data line if part of product
BAND5_GAIN	1	= "L" for low or "H" for high	Gain state for band 5's first data line if part of product
BAND6_GAIN1	1	= "L" for low or "H" for high	Gain state for band 6 low's first data line if part of product
BAND6_GAIN2	1	= "L" for low or "H" for high	Gain state for band 6 high's first data line if part of product
BAND7_GAIN	1	= "L" for low or "H" for high	Gain state for band 7's first data line if part of product
BAND8_GAIN	1	= "L" for low or "H" for high	Gain state for band 8's first data line if part of product
SUN_AZIMUTH	8	= 0.0000 through 360.0000 degrees (with 4-digit precision)	Sun azimuth angle in degrees for image center location at image center acquisition time
SUN_ELEVATION	8	= 0.0000 through 360.0000 degrees (with 4-digit precision)	Sun elevation angle in degrees for image center location at image center acquisition time
OUTPUT_FORMAT	7	= "HDF-EOS", "FAST", or "GeoTIFF"	Output format of image
END_GROUP	18	= PRODUCT_PARAMETERS	End of product parameters group
GROUP	19	= CORRECTIONS_APPLIED	Beginning of corrections applied group
STRIPING	1	= "Y" or "N"	Indicator of whether image was corrected for striping
BANDING	1	= "Y" or "N"	Indicator of whether image was corrected for banding
COHERENT_NOISE	1	= "Y" or "N"	Indicator of whether image was corrected for coherent noise
MEMORY_EFFECT	1	= "Y" or "N"	Indicator of whether image was corrected for memory effect
SCAN_CORRELATED_SHIFT	1	= "Y" or "N"	Indicator of whether image was corrected for scan correlated shift
INOPERABLE_DETECTORS	1	= "Y" or "N"	Indicator of whether image was corrected for inoperable detectors
SATURATED_DETECTORS	1	= "Y" or "N"	Indicator of whether image was corrected for saturated detectors
DROPPED_LINES	1	= "Y" or "N"	Indicator of whether image was corrected for dropped lines
END_GROUP	19	= CORRECTIONS_APPLIED	End of corrections applied group
GROUP	21	= PROJECTION_PARAMETERS	Beginning of projection parameters group (1G product only)
REFERENCE_DATUM	5	= "WGS84"	Datum used by LPGS in creating image
REFERENCE_ELLIPSOID	6	= "WGS_84"	Ellipsoid used by LPGS in creating image
GRID_CELL_SIZE	21	= 15.000 through 60.000 meters, in increments of .001 meters, for each of the 3 band types in the following order: pan, reflective, thermal	Size of grid cell used by LPGS in creating image for each band type
ORIENTATION	3	= "NOM" for nominal path = "NUP" for North up	Orientation used by LPGS in creating image

Table 4-1. LPGS Metadata File (5 of 7)

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
RESAMPLING_OPTION	4	= "NN" for nearest neighbor = "CC" for cubic convolution = "MTFC" for modulation transfer function compensation	Resampling option used by LPGS in creating image
MAP_PROJECTION	3	= "SOM" for space oblique mercator = "UTM" for universal transverse mercator = "LCC" for Lambert conformal conic = "TM" for transverse mercator = "OM" for oblique mercator = "PC" for polyconic = "PS" for polar stereographic	Map projection used by LPGS in creating image
END_GROUP	21	= PROJECTION_PARAMETERS	End of projection parameters group
Projection parameters data (not an LPGS metadata parameter)			The following parameters are included only with products that select a map projection of LCC
GROUP	14	LCC_PARAMETERS	Beginning of LCC parameters group
LATITUDE_OF_FIRST_STANDARD_PARALLEL	11	= -90.0 to +90.0	Latitude of first standard parallel
LATITUDE_OF_SECOND_STANDARD_PARALLEL	11	= -90.0 to +90.0	Latitude of second standard parallel
LONGITUDE_OF_CENTRAL_MERIDIAN	12	= -180.0 to +180.0	Longitude of central meridian
LATITUDE_OF_PROJECTION_ORIGIN	11	= -90.0 to +90.0	Latitude of projection origin
FALSE_EASTING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False easting
FALSE_NORTHING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False northing
FALSE_EASTING_NORTHING_UNITS	6	= "meters" or "feet"	Units for false easting and northing for LCC projection
END_GROUP	14	LCC_PARAMETERS	End of LCC parameters group
Projection parameters data (not an LPGS metadata parameter)			The following parameters are included only with products that select a map projection of TM
GROUP	13	TM_PARAMETERS	Beginning of TM parameters group
SCALE_FACTOR_AT_CENTRAL_MERIDIAN	11	= 0.0 to 2.0	Scale factor at central meridian
LONGITUDE_OF_CENTRAL_MERIDIAN	12	= -180.0 to +180.0	Longitude of central meridian
LATITUDE_OF_PROJECTION_ORIGIN	11	= -90.0 to +90.0	Latitude of projection origin
FALSE_EASTING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False easting
FALSE_NORTHING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False northing
FALSE_EASTING_NORTHING_UNITS	6	= "meters" or "feet"	Units for false easting and northing for TM projection
END_GROUP	13	TM_PARAMETERS	End of TM parameters group
Projection parameters data (not an LPGS metadata parameter)			The following parameters are included only with products that select a map projection of PC
GROUP	13	PC_PARAMETERS	Beginning of PC parameters group
LONGITUDE_OF_CENTRAL_MERIDIAN	12	= -180.0 to +180.0	Longitude of central meridian
LATITUDE_OF_PROJECTION_ORIGIN	11	= -90.0 to +90.0	Latitude of projection origin
FALSE_EASTING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False easting
FALSE_NORTHING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False northing

Table 4-1. LPGS Metadata File (6 of 7)

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
FALSE_EASTING_NORTHING_UNITS	6	= "meters" or "feet"	Units for false easting and northing for PC projection
END_GROUP	13	P C_PARAMETERS	End of PC parameters group
Projection parameters data (not an LPGS metadata parameter)			The following parameters are included only with products that select a map projection of PS
GROUP	13	PS_PARAMETERS	Beginning of PS parameters group
VERTICAL_LONGITUDE_FROM_POLE	12	= -180.0 to +180.0	Vertical longitude from pole
LATITUDE_OF_TRUE_SCALE	11	= -90.0 to +90.0	Latitude of true scale
SCALE_FACTOR_AT_PROJECTION_ORIGIN	9	= 0.0 to 2.0	Scale factor at projection origin
FALSE_EASTING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False easting
FALSE_NORTHING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False northing
FALSE_EASTING_NORTHING_UNITS	6	= "meters" or "feet"	Units for false easting and northing for PS projection
END_GROUP	13	PS_PARAMETERS	End of PS parameters group
Projection parameters data (not an LPGS metadata parameter)			The following parameters are included only with products that select a map projection of OM
GROUP	13	OM_PARAMETERS	Beginning of OM parameters group
SCALE_FACTOR_AT_CENTER_OF_PROJECTION	9	= 0.0 to 2.0	Scale factor at center of projection
LATITUDE_OF_PROJECTION_ORIGIN	11	= -90.0 to +90.0	Latitude of projection origin
FALSE_EASTING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False easting
FALSE_NORTHING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False northing
OM_TYPE	1	= "A" or "B"	Value used to indicate type of OM projection
END_GROUP	13	OM_PARAMETERS	End of OM parameters group
Projection parameters data (not an LPGS metadata parameter)			The following parameters are included only with products that select a map projection of OMA
GROUP	14	OMA_PARAMETERS	Beginning of OMA parameters group
LONGITUDE_FIRST_POINT_GEODETTIC	12	= -180.0 to +180.0	Longitude of first point defining central geodetic line of projection
LATITUDE_FIRST_POINT_GEODETTIC	11	= -90.0 to +90.0	Latitude of first point defining central geodetic line of projection
LONGITUDE_SECOND_POINT_GEODETTIC	12	= -180.0 to +180.0	Longitude of second point defining central geodetic line of projection
LATITUDE_SECOND_POINT_GEODETTIC	11	= -90.0 to +90.0	Latitude of second point defining central geodetic line of projection
END_GROUP	14	OMA_PARAMETERS	End of OMA parameters group
Projection parameters data (not an LPGS metadata parameter)			The following parameters are included only with products that select a map projection of OMB
GROUP	14	OMB_PARAMETERS	Beginning of OMB parameters group
ANGLE_OF_AZIMUTH	12	= -180.0 to +180.0	Angle of azimuth east of north for central line of projection
LONGITUDE_ALONG_PROJECTION	12	= -180.0 to +180.0	Longitude of point along central line of projection at which angle of azimuth is measured
END_GROUP	14	OMB_PARAMETERS	End of OMB parameters group

Table 4-1. LPGS Metadata File (7 of 7)

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
Projection parameters data (not an LPGS metadata parameter)			The following parameters are included only with products that select a map projection of UTM
GROUP	14	UTM_PARAMETERS	Beginning of UTM parameters group
ZONE_NUMBER	3	= 1 to 60 or -1 to -60	Value used to indicate zone number
END_GROUP	13	UTM_PARAMETERS	End of UTM parameters group
END_GROUP	148	LPGS_METADATA_FILE	End of LPGS metadata file level group
END			Required standalone parameter signifying file end

*ASCII bytes

Table 4-2. Vgroup Definitions

Vgroup Name	Vgroup Class	Object Name	Type	Description
Scene_Data	Image_Data	L71ppprrr_rrrYYYYMMDD_B10.xxx	SDS	ETM+ band 1 data
		L71ppprrr_rrrYYYYMMDD_B20.xxx	SDS	ETM+ band 2 data
		L71ppprrr_rrrYYYYMMDD_B30.xxx	SDS	ETM+ band 3 data
		L71ppprrr_rrrYYYYMMDD_B40.xxx	SDS	ETM+ band 4 data
		L71ppprrr_rrrYYYYMMDD_B50.xxx	SDS	ETM+ band 5 data
		L71ppprrr_rrrYYYYMMDD_B61.xxx	SDS	ETM+ band 6 low gain data
		L72ppprrr_rrrYYYYMMDD_B62.xxx	SDS	ETM+ band 6 high gain data
		L72ppprrr_rrrYYYYMMDD_B70.xxx	SDS	ETM+ band 7 data
		L72ppprrr_rrrYYYYMMDD_B80.xxx	SDS	ETM+ band 8 data
IC_Data	Correction_Data	L71ppprrr_rrrYYYYMMDD_CAL.xxx	SDS	IC data bands 1 through 6 low gain
		L72ppprrr_rrrYYYYMMDD_CAL.xxx	SDS	IC data bands 6 high gain through 8
Geolocation_Index	Correction_Data	L71ppprrr_rrrYYYYMMDD_GEO.xxx	Vdata	Geolocation index
Scan_Line_Offsets	Correction_Data	L71ppprrr_rrrYYYYMMDD_SLO.xxx	Vdata	Scan line offsets bands 1 through 6 low gain
		L72ppprrr_rrrYYYYMMDD_SLO.xxx	Vdata	Scan line offsets bands 6 high gain through 8
PCD	Correction_Data	L71ppprrr_rrrYYYYMMDD_PCD.xxx	Vdata	Consensus PCD
MSCD	Correction_Data	L71ppprrr_rrrYYYYMMDD_MSD.xxx	Vdata	Consensus MSCD
Product_Metadata	Metadata	L71ppprrr_rrrYYYYMMDD_MTA.xxx	Vdata	LPS metadata format 1
		L72ppprrr_rrrYYYYMMDD_MTA.xxx	Vdata	LPS metadata format 2
		L71ppprrr_rrrYYYYMMDD_MTL.xxx	Vdata	LPGS product specific metadata
CPF	Correction_Data	L7CPF.YYYYYMMDD_YYYYMMDD.nn	Vdata	IAS CPF

Appendix A. Projection Parameters

This appendix contains the map projection parameters used in the LPGS L1G products (Table A-1).

Table A-1. USGS Projection Parameters

(A) Projection Transformation Package Projection Parameters Elements 1-8

Code and Projection ID	Array Element							
	1	2	3	4	5	6	7	8
UTM	Lon/Z	Lat/Z						
Lambert Conformal C	SMajor	SMinor	STDPR1	STDPR2	CentMer	OriginLat	FE	FN
Polar Stereographic	SMajor	SMinor			LongPol	TrueScale	FE	FN
Polyconic	SMajor	SMinor			CentMer	OriginLat	FE	FN
Transverse Mercator	SMajor	SMinor	Factor		CentMer	OriginLat	FE	FN
Hotine Oblique Merc A	SMajor	SMinor	Factor			OriginLat	FE	FN
Hotine Oblique Merc B	SMajor	SMinor	Factor	AziAng	AzmthPt	OriginLat	FE	FN
Space Oblique Merc B	SMajor	SMinor	Satnum	Path			FE	FN

(B) Projection Transformation Package Projection Parameters Elements 9-15

Code and Projection ID	Array Element				
	9	10	11	12	13
UTM					
Lambert Conformal C					
Polar Stereographic					
Polyconic					
Transverse Mercator					
Hotine Oblique Merc A	Long1	Lat1	Long2	Lat2	zero
Hotine Oblique Merc B					one
Space Oblique Merc B					one

where

Lon/Z = longitude of any point in the UTM zone or zero. If zero, a zone code must be specified

Lat/Z = latitude of any point in the UTM zone or zero. If zero, a zone code must be specified

SMajor = semi-major axis of ellipsoid. If zero, Clarke 1866 in meters is assumed

SMinor = eccentricity squared of the ellipsoid if less than zero. If zero, a spherical form is assumed, or if greater than zero, the semi-major axis of ellipsoid
 STDPR1 = latitude of the first standard parallel
 STDPR2 = latitude of the second standard parallel
 CentMer = longitude of the central meridian
 OriginLat = latitude of the projection origin
 FE = false easting in the same units as the semi-major axis
 FN = false northing in the same units as the semi-major axis
 LongPol = longitude down below pole of map
 TrueScale = latitude of true scale
 Factor = scale factor at central meridian (Transverse Mercator) or center of projection (Hotine Oblique Mercator)
 Long1 = longitude of first point on center line (Hotine Oblique Mercator, format A)
 Long2 = longitude of second point on center line (Hotine Oblique Mercator, format A)
 Lat1 = latitude of first point on center line (Hotine Oblique Mercator, format A)
 Lat2 = latitude of second point on center line (Hotine Oblique Mercator, format A)
 AziAng = azimuth angle east of north of center line (Hotine Oblique Mercator, format B)
 AzmthPt = longitude of point on central meridian where azimuth occurs (Hotine Oblique Mercator, format B)
 Satnum = Landsat satellite number (SOM, format B)
 Path = Landsat path number (use WRS-1 for Landsat 1, 2, and 3 and WRS-2 for Landsat 4, 5, 6, or 7) (SOM, format B)

NOTES: Array elements 14 and 15 are set to zero. All array elements with blank fields are set to zero. All angles (latitudes, longitudes, azimuths, etc.) are entered in packed degrees/minutes/seconds (DDMMSS.SS) format.

Abbreviations and Acronyms

ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
CPF	calibration parameter file
DAAC	Distributed Active Archive Center
DCN	document change notice
DFCB	data format control book
ECS	EOSDIS Core System
EDC	EROS Data Center
EOS	Earth Observing System
EOSAT	Earth Observation Satellite
EOSDIS	EOS Data and Information System
EROS	Earth Resources Observation System
ESDIS	Earth Science Data and Information System
ETM+	Enhanced Thematic Mapper plus
F&PRS	Functional and Performance Requirements Specification
GeoTIFF	Georeference Tagged Image File Format
GMT	Greenwich mean time
GSFC	Goddard Space Flight Center
HDF	hierarchical data format
HDF-EOS	hierarchical data format - Earth Observing System
IAS	Image Assessment System
IC	internal calibrator
ICD	interface control document
L0R	Level 0 radiometrically corrected
L1	Level 1
L1G	Level 1 geometrically corrected
L1R	Level 1 radiometrically corrected

LPGS	Level 1 Product Generation System
LPS	Landsat Processing System
MSCD	mirror scan correction data
NASA	National Aeronautics and Space Administration
ODL	object description language
PCD	payload correction data
PCMB	Project Configuration Management Board
TBD	to be defined/determined
TBS	to be supplied
WRS	Worldwide Reference System
0R	zero R data
Zulu	Greenwich mean time